UNDERGROUND STORAGE TANK

This application claims the benefit of U.S. Provisional Application Serial Number 60/461,849 filed April 10, 2003, and is a Continuation-in-Part of Application Serial Number 10/055,440 filed January 23, 2002.

Background of the Invention

1. Field of the Invention

This invention broadly concerns storage tanks which are intended for use below grade for receiving and storing liquids and solids, such as for use as a septic tank, pump tank, dose tank, holding tank, or cistern. More particularly, it is concerned with such a tank which may be molded of synthetic resin material and configured for enhanced structural support and stability.

2. Description of the Prior Art

Underground storage tanks are well known for use as septic tanks and cisterns. Such tanks have long been constructed of concrete and metal for their durability and extended life. However, concrete tanks for storing liquid or septic tank use are heavy and difficult to place, and may be subject to leakage over extended periods due to the shifting of the earth around the tank. Metal tanks are expensive to fabricate and may be subject to corrosion.

More recently, synthetic resin has been used to make underground storage and septic tanks. Relatively large volume tanks may be fabricated of fiberglass reinforced plastic, high density polyethylene and other resilient synthetic resins using rotational molding techniques. These tanks have significant advantages in terms of cost and weight, and have proven useful for retaining and storing water, sewage, and other materials. Examples of synthetic resin storage tanks useful in water storage and septic tank applications include those shown in U.S. Patent Nos. 4,254,885, 4,961,670, 5,242,584, 5,361,930 and 6,328,890, and published U.S. Patent Applications US2002-0153380A1 and US2002-0185433A1, the disclosures of which are incorporated herein by reference.

One problem encountered during use of most underground storage tanks is that the synthetic resin tanks may be subject to deformation caused by a variety of factors. For example, when filled with water, sewage or other liquid, the load on the tank by the weight of the contents may cause significant distortion. Another source of deformation is caused by changes in soil moisture whereby the earth adjacent the tank may expand and contract. This may occur unevenly, further complicating the ability of the synthetic resin tank to withstand deformation caused by these external forces.

Tractors, farm animals and other sources of surface loading may be transmitted to the underground tank, causing deformation. In short, a wide variety of differences in internal and external forces acting on the tank may cause the tank walls to bend or flex. When significant bending or flexing occurs, the manhole opening to the tank may deform sufficiently to prevent attachment of the manhole cover, or cause separation of pipes and fittings leading to the tank, or under severe loading and environmental conditions cause cracking of the tank wall. Under these circumstances, the tank may be rendered inoperative and must be repaired, if possible, or replaced.

There has thus developed a need for an improved tank of synthetic resin construction having an enhanced ability to withstand internal and external forces without significant deformation which leads to tank failure.

Summary of the Invention

These objects have largely been met by the tank of the present invention. The tank hereof is designed to resist deformation, particularly in the region of the manhole opening. In addition, the tank hereof includes internal reinforcements which help resist the collapse of the upper wall downwardly toward the lower wall or upwardly from the lower wall to the upper wall. The reinforcements may be distributed within the internal chamber of the tank to maintain the initial shape of the tank even when subjected to significant external forces and/or filled with liquid. Further, the tank may be constructed so that the reinforcements do not significantly affect the capacity of the tank.

The tank of the present invention includes a shell which is preferably molded in a unitary member of a synthetic resin material. The shell is provided with at least one opening. Preferably, the shell has an opening sufficiently sized to permit ingress and egress of a human into the chamber within the tank, and additional openings to permit the attachment of pipes for the receipt and discharge of liquid, such as water or sewage. The shell is molded into an elongated shape along a major axis with rounded ends and when viewed along its major axis, its upper wall is seen to be generally arcuate and the lower portion of the shell has arcuate edges with a relatively large radius which aids in distributing loading on and from within the shell. Furthermore, the upper wall and lower wall are provided with reinforcing pockets formed therein which resist deformation when the tank is filled and placed below ground. The reinforcing pockets are preferably arranged in sets, whereby the reinforcing pockets in one set are aligned with respective reinforcing pockets in another set. The arrangement is most preferably such that a reinforcing pocket may be aligned both vertically with another reinforcing pocket and laterally across from another reinforcing pocket formed in the shell.

The tank hereof may be constructed with several alternative ways of reinforcement. In one alternative configuration, the reinforcing pockets alone are used to maintain the shape of the tank and resist deformations. In this configuration, the reinforcing pockets are closed and the tank is configured for maximum volume, with the shell of the tank resisting deformation. The reinforcement pockets may also be designed with additional depth, such that two reinforcement pockets positioned in substantial vertical alignment are closely proximate or meet at all or a portion of their base wall, so that the two vertically aligned reinforcement pockets cooperate with one another to provide mutual support.

In a second alternative configuration, the reinforcing pockets are also closed but configured to act as reinforcing mounts which project inwardly into the chamber. The reinforcing mounts are preferably configured and oriented in opposition to one another, elongated reinforcing members may be coupled to the mounts between opposing sections of the shell. Thus, the reinforcing mounts are molded into the wall of the shell and configured to resist collapse of one part of the wall towards another and do not provide additional openings into or through the shell. Moreover, the reinforcing mounts are preferably located at indentations molded into the tank whereby the indentation walls provide structural strength and support to the adjacent arcuate portion of the shell in combination with the internal reinforcements. That is to say, the indentation walls help carry the loading of the shell along with the reinforcements such that the shell and internal reinforcements act in combination.

In this embodiment, the reinforcements are preferably discrete members which are mounted on the reinforcing mounts. Most preferably, the reinforcements are tubular members which may be cylindrical in configuration and oriented substantially vertically in use. The reinforcements may be provided of a chemically resistant material, such as high density polyethylene, and may be perforated whereby the capacity of the tank is not substantially reduced by their inclusion, yet the structural support provided is not significantly affected. The reinforcements are preferably installed by obtaining access to the chamber within the shell through manway openings, and use of a jack, ram or other shiftable member capable of moving the shell apart between opposing reinforcement mounts, inserting the reinforcements between the mounts to be received thereon. Because the load carried by the reinforcements is primarily compressive, it is not necessary to affix the reinforcements to the mounts by the application of fasteners such as screws, bonding agents or thermal bonding, although this can be done if desired. Most preferably, the mounts include sleeves which partially extend into each end of the reinforcements to hold the reinforcements in position against lateral displacement or dislodgment from the mounts.

In a third alternative, the reinforcing pockets include openings therein. The openings communicate fluidically with one another by molded-in-place columns. The columns are preferably molded by the use of kiss-throughs in the moulding process, whereby the columns are formed integrally with the shell. The columns allow water to drain down through the columns or permit a rising water table in the earth to rise through the columns while retaining isolation of the tank contents from such water. It may be appreciated that the molded-in-place columns may be more economically molded than the insertion of the interior columns as described above, but with the consequent disadvantage of loss of some storage capacity. The columns may be molded to be tapered along their length so that the columns are generally frustoconical in configuration. Alternatively, the molded-in-place columns may present an hourglass-type shape, where they taper to a narrowest portion intermediate the openings in the upper and lower reinforcing pockets.

The shell is preferably configured in an elongated orientation having modified dome-shaped ends, provided a modified extended spherical configuration. Stabilization lugs, as shown in my pending U.S. Patent Application Ser. No. 10/055,440 filed January 23, 2002, the disclosure of which is incorporated herein by reference, are located at the corners of the shell and are integrally molded therein, the lugs including openings therein for receiving rods or other anchoring members. As mentioned above, the shell preferably includes one, and most preferably two or more manway openings integrally molded therein. The manway openings are preferably circular and have a collar with a circumscribing trough adjacent thereto. The trough is permitted to flex and deform under vertical loading in use, and as a result, the collar is isolated from much of the deformation which would otherwise occur. By the use of such a circumscribing trough, the collar retains its shape under a variety of loading conditions and thus the manway cover can be coupled to the collar under such varying load conditions. Moreover, the manway openings are recessed to a sufficient degree to isolate not only the rims of the manways but also their covers from extension above the upper wall of the shell and thereby reduce deformation due to external forces or the contents of the tank. By such a construction, the usual problems associated with synthetic resin tanks designed for underground storage of liquids such as water tanks, septic tanks and the like are large ameliorated.

Another feature of the tank of the present invention is the inclusion of lifting lugs and adjacent, complementally located and configured recesses. These lugs and recesses are preferably molded into the

Brief Description of the Drawings

Fig. 1 is a perspective view of my new underground storage and septic tank showing the shell having the stabilization lugs, reinforcements, and the collar with the circumscribing troughs on the manway openings, with the manway covers shown attached to the shell and inlet and vent pipes shown in dashed lines;

Fig. 2 is a plan view of the underground storage and septic tanks of Fig. 1, showing the circumscribing troughs around the manway openings and the reinforcement mounts in the top of the shell;

Fig. 3 is a side elevational view of the tank showing the longitudinally and laterally spaced receiving pockets each with a reinforcement mount and the covers mounted on the collars of the manways;

Fig. 4 is a perspective view shown in vertical section along line 4-4 of Fig. 2 to show the reinforcements in vertical orientation between opposed reinforcement mounts;

Fig. 5 is a vertical cross-sectional view taken along line 5-5 of Fig. 3, showing the reinforcement members and the reinforcement mounts in the chamber of the tank with the cover removed;

Fig. 6 is an enlarged, fragmentary vertical sectional view of one of the manways showing the trough and the collar;

Fig. 7 is an enlarged, bottom view of one of the covers for the manway;

Fig. 8 is an enlarged, vertical sectional view taken along line 8-8 of Fig. 7 through one of covers and showing the cover in an inverted orientation;

Fig. 9 is a perspective view of a second embodiment of the tank of the present invention wherein the receiving pockets are provided with openings and the ends of the tank include a castellated extension for receiving inlet and vent piping, shown in dashed lines;

Fig. 10 is a top plan view of the tank of Fig. 9 with one of the covers attached to a manway and the other manway having the cover removed;

Fig. 11, is a side elevational view of the tank of Fig. 9;

Fig. 12 is a vertical cross-sectional view taken along line 12-12 of Fig. 11, showing the molded-in tubular members extending vertically between openings in the receiving pockets as having a frustoconical shape;

Fig. 13 is a vertical cross-sectional view taken along line 12-12 of Fig. 11 showing an alternate configuration of the molded-in tubular members as tapered to a waist which is narrowed relative to cross-sectional areas of the openings;

Fig. 14 is a side elevational view of two of the tanks of Fig. 9 in stacked, top-to-top relationship, with portions of the upper wall of each tank broken away to

show the lifting lugs of each tank are nested into recesses of the other tank stacked therewith;

Fig. 15 is a perspective view of a third embodiment of the tank of the present invention, wherein the receiving pockets have a substantially flat, imperforate base wall;

Fig. 16 is a vertical cross-sectional view taken transverse to the longitudinal axis of the tank of Fig. 15 and similar to the view shown in Fig. 12, showing the chamber within the tank;

Fig. 17 is a side elevational view of a further embodiment of the tank of the present invention, showing the receiving pockets extending in a vertical direction such that the vertically aligned receiving pockets meet to provide mutual support, the opposite side being substantially a mirror image; and

Fig. 18 is a vertical cross-sectional view taken along line 18-18 of Fig. 17, showing the interconnection of the base walls of the receiving pockets substantially midway along the side walls of the shell.

Description of the Preferred Embodiment

Referring now to the drawings, a underground storage and septic tank 10 may be used for receiving, storing and discharging liquids such as water or a combination of liquids and solids such as sewage. The tank 10 broadly includes a shell 12 and at least one, and preferably a plurality of covers 14 removably mounted on the shell 12. The shell 12 encloses a chamber 16. The shell 12 and the covers 14 are preferably rotationally molded of a synthetic resin such as high density polyethylene (HDPE), and is of unitary construction. The covers 12, and the details of the manways on which they are mounted, are shown in Figs. 7 and 8 and are common to each of the embodiments described herein. As used in this application, the terms "upright", "vertical", and "horizontal" are used for ease of reference in regard to the position of the tank 10 in normal operation.

In the tank 10 shown in Figs. 1-6, at least one, and preferably a plurality of reinforcements 18 are mounted in upright orientation within the chamber 16. The shell 12 is unitary and molded as a single unit. The shell 12 includes at least one, and preferably a plurality of manways 20, an outer wall 22, reinforcement mounts 24, and stabilization lugs 26. The outer wall 22 of the shell 12 is preferably configured along a longitudinal axis which extends generally along line 4-4 of Fig. 2, and a vertical plane extending upwardly through the longitudinal axis substantially bisects the tank 10 lengthwise. The tank 10 is elongated with generally dome-shaped ends 28 and 30. The manways 20 are provided along the upper wall 32 of the outer wall 22 when the tank 10

is in use. Each of the manways includes an upright cylindrical collar 34 surrounded by a trough 36 which is recessed inwardly toward the chamber 16. The outer wall 22 also includes a lower wall 37 having arcuate lateral edges and a substantially flat bottom surface, and may have a side wall 39 which is substantially flat in an upright direction and which partially wraps around the dome-shaped ends.

The shell also includes a plurality of receiving pockets 38 each of which include a pair of opposing side walls 40 and 42, an upright inboard wall 44 and a generally laterally extending base wall 46, the reinforcement mounts 24 being integrally molded as a part of the base wall 46. The receiving pockets 38 are arranged in opposed pairs both vertically and laterally when the tank 10 is in use. Thus, receiving pockets 38a and 38b, 38c and 38d, and 38e and 38f are laterally displaced relative to each other along the upper side 32 of the outer wall 22, and receiving pockets 38g and 38h, 38i and 38j, and 38k and 38l are laterally displaced relative to each other along the lower side 48 of the outer wall 22. In addition, receiving pocket 38a is positioned in alignment above receiving pocket 38g, receiving pocket 38b is positioned in alignment above receiving pocket 38h, receiving pocket 38c is positioned in alignment above receiving pocket 38i, receiving pocket 38d is positioned in alignment above receiving pocket 38j, receiving pocket 38e is positioned in alignment above receiving pocket 38k, and receiving pocket 38f is positioned in alignment above receiving pocket 38l. The vertical alignment of the receiving pockets 38 permits the mounting of the reinforcements 18 on the reinforcement mounts 24 between the base walls 46, and the longitudinal and lateral spacing of the receiving pockets 38 provides additional strength to the shell 12 in addition to the strength added by the reinforcements 18.

The base wall 46 of the receiving pockets is extends substantially horizontally when the tank 10 is in its normal position of use. The upright inboard wall 44 of the receiving pockets may lie in a plane substantially parallel to a vertical plane through the longitudinal axis of the tank 10, as is shown in regard to pockets 38c, 38d, 38i and 38j, or lie in a plane which intersects a vertical plane through the longitudinal axis as is shown in regard to the upright inboard walls 44 of receiving pockets 38a, 38b, 38e, 38f, 38g, 38h, 38k and 38l. Such an angled orientation may be useful to provide greater support when the pockets 38 are positioned with greater lateral spacing so that they are located on the dome-shaped ends 28 and 30 as shown in the tank 10 of Figs. 1-6. The receiving pockets may be grouped into sets for ease of reference. Thus, a set of receiving pockets 38 may include receiving pockets 38a, 38c and 38e along one side of the upper wall of the tank, and another set 38g, 38i and 38k which are positioned respectively beneath the pockets 38a, 38c and 38e. Another grouping may be to consider the receiving pockets on one side of a upright plane bisecting the tank in one set (e.g.,

receiving pockets 38a, 38c, 38e, 38g, 38i and 38k) and the receiving pockets on the other side of the bisecting plane in another set (e.g., receiving pockets 38b, 38d, 38f, 38h, 38j and 38l). Further, the receiving pockets 38 can be grouped into pairs, such as superposed pairs 38a and 38g, 38b and 38h, etc.) or lateral pairs (e.g., 38a and 38b, 38c and 38d, 38g and 38h, etc.).

The upper wall 32 of the outer wall of the shell 12 is generally arcuate when viewed along the longitudinal axis as seen in Fig. 5, and includes an arcuate top surface 48 having arcuate edges 50 and 52 from which an arcuate, upright shoulder wall 54 extends downwardly to the trough 36 of each of the manways 20. The domed-shaped ends 28 and 30 also include margins 56 and 58 respectively, from which an arcuate, upright panel wall 60 extends downwardly to the trough of each of the manways 20. The upright shoulder wall 54 is longitudinally separated from and opposed to the upright panel wall 60 for each of the manways 20, with receiving pockets 38 separating them. The receiving pockets 38a and 38b communicate with one of the troughs 36 and receiving pockets 38e and 38f communicate with the other of the troughs 36. This not only relieves stress on the manways 20 but also faciliates drainage from the troughs 36 down into the receiving pockets 38 so that water or other material collected into the troughs does not enter the chamber through the manways when the covers are removed. The receiving pockets 38 are all provided with radiused internal corners to reduce stress concentrations and facilitate load transfers through the receiving pockets to the outer wall.

The dome-shaped ends 28 and 30 each include an upright recess 62 extending inwardly toward the chamber and having a flat end-facing wall 63, and also present upright flat end walls 64. The upright recesses 62 extend vertically the majority of the height of the tank 10. The recesses 62 provide additional structural rigidity to the shell 12 and enable an anchoring member to be received therein to retard longitudinal or lateral movement of the tank 10. Also, as shown in that application, the outer wall of the shell may include a plurality of longitudinally spaced, circumferentially oriented reinforcing ribs to provide additional strength to the shell 12. The tanks 10 are also preferably provided with suitable passages including fittings for receiving piping and provided with gaskets or the like, preferably located in the recesses of the dome shaped ends, by which liquid such as water or a combination of liquids and solids as in sewage may be received and discharged, all as shown in my co-pending U.S. Application No. 10/055,440, the disclosure of which is incorporated herein by reference. Thus, the flat end-facing walls of the recesses 62 on the dome-shaped ends 28 and 30 are suitable for allowing the installer to make a hole into the tank 10 for the mounting of vent piping 65 and inlet piping 67 for introducing liquid such as water or sewage into the chamber 16.

The stabilization lugs 26 are located in opposed pairs on the dome-shaped ends 28 and 30 to be essentially positioned at corners of the shell 12, each of the stabilization lugs 26 being molded in hollow, substantially L-shaped configurations integrally with the outer wall 22 to provide a hole 66 for the receipt of rods, posts or other anchoring members through the hole 66. The stabilization lugs 26 thus fluidically communicate with the chamber 16, and include a first arm 80 extending substantially horizontally and substantially parallel to the longitudinal axis and a second arm 82 extending substantially horizontally and substantially perpendicular to the longitudinal axis.

The reinforcement mounts 24 are positioned in the receiving pockets 38 and preferably configured with a flat, substantially annular base 68 and a short cylindrical stub tube 70 extending from the base 68 inwardly from the inner surface 71 of the pockets 38 into the chamber. Alternatively, the reinforcement mounts could be molded as simple recesses or grooves along the inner surface 71 of the base wall of the receiving pockets 38 to hold the reinforcements in position. The stub tube 70 has an enclosed end 72 to maintain the chamber against leakage therethrough. The reinforcements 18 are members, and preferably tubes, in the shape of cylinders complemental to the configuration of the mounts 24 so that the ends 74 and 76 of the reinforcements 18 are engaged against the base 68 and held against lateral movement by the tubes 70 of the mounts. Because the end 72 of each mount 24 is enclosed, the reinforcements 18 may be provided with perforations 73 to permit the flow of liquid therein so that no substantial reduction of the volume of the chamber is caused by the use of the reinforcements 18 therein. It may be appreciated that the tubes could be square or a variety of other shapes in cross section, and that the base 68 could be enclosed if desired so that the reinforcements 18 are received within the tubes 70 rather than positioned with the tubes 70 extending into the reinforcements 18 as shown in the drawings. The receiving pockets 38 positioned on opposite sides of the manways 20 receive water draining off of the troughs 36 and the base wall of each receiving pocket 38 is inclined downwardly from the inboard to the outboard to facilitate further drainage.

The collars 34 of each of the manways 20 include recesses in the rim 74 which receive complementally positioned and spaced radially inwardly projecting lugs 78 on the covers 14 so that the covers 14 (shown in Figs. 7 and 8 detached from the tank 10) may be pushed down and twisted into locking condition with the manways. The manways 20 may also receive risers thereon which increases the effective depth below grade in which the tanks 10 may be placed. The tanks 10 are also preferably provided with suitable passages including fittings for receiving piping and provided with gaskets or the like, preferably located in the recesses of the dome shaped ends, by which liquid

such as water or a combination of liquids and solids as in sewage may be received and discharged, all as shown in my co-pending U.S. Application No. 10/055,440, the disclosure of which is incorporated herein by reference. Also, as shown in that application, the outer wall of the shell may include a plurality of longitudinally spaced, circumferentially oriented reinforcing ribs to provide additional strength to the shell 12.

The shell 12 is preferably integrally molded of synthetic resin, such as high density polyethylene by rotational molding. The covers 14 are separately molded also preferably of a synthetic resin such as high-density polyethylene and are double-walled, having a space between the upper and lower wall layers which provides both thermal insulation and greater resistance to impact.

In the case of tank 10, the reinforcement mounts 24 are molded into the shell. The reinforcements 18 may be of a variety of materials but are preferably molded of a synthetic resin such as high-density polyethylene or polyvinylchloride (PVC). After the completion of the molding, the shell 12 is entered through the manway 20 and the base walls 46 are pushed apart by a mechanical jack or ram or by the strength of the installer so that the reinforcements 18 may be positioned over the tubes of the reinforcement mounts 24. Once the separating force applied between the receiving pockets 38 is removed, the reinforcements 18 are firmly positioned between the opposing mounts 24 and captured thereon. In the embodiment illustrated in Figs. 1-6, the reinforcements 18 are in upright, substantially vertical orientation, but the receiving pockets and their opposing mounts could be formed so that the reinforcements 18 are lateral, substantially horizontally oriented, or a combination of some upright orientations and some laterally oriented. For example, if some of the receiving mounts are formed in the upright inboard wall 44 of laterally spaced receiving pockets, e.g. receiving pockets 38a and 38b, then the reinforcements 18 could be positioned for providing lateral reinforcement. Moreover, in the construction of the tank 10 hereof, receiving mounts could be formed in both the base walls 46 and the upright inboard walls 44 of the receiving pockets, so that the reinforcements 18 could be mounted in both vertical and horizontal orientations, providing yet further strength and reinforcement to the shell 12 without substantially affecting the capacity of the chamber.

A second embodiment of the tank 10A of the present invention is shown in Figs. 9 through 14, with like numbers used to represent like features. With regard to the tank 10A, a plurality of ribs 90 are formed in the outer wall 22 to provide additional structural rigidity in a circumferential direction. The ribs 90 are formed by slots 92 extending inwardly toward the chamber 16, and include upright slots 94 which are formed in the side walls 37 and extend into the upper wall 32 and the lower wall 39, upper transverse slots 96 extending across the upper wall 32, and lower transverse slots

98 extending across the lower wall. As may be seen by Fig. 9, some of the upright slots 94 extend between and communicate with superposed pairs of the receiving pockets 38 to further promote drainage and provide structural rigidity. In addition, at least one of the upper transverse slots 96 extends between and communicates with two laterally spaced receiving pockets, and as seen in Fig. 11, some of the lower transverse slots 98 extend across to communicate with laterally opposed receiving pockets 38, while others of the lower transverse slots 98 extend between the arcuate portions of the lower wall longitudinally intermediate the receiving pockets 38 on the lower wall.

The upper wall 32 is also provided with lifting lugs 100 extending upwardly from the top surface 42 which include a transverse opening 102 to facilitate receipt of a hook or cable for lifting the tank 10A. A recess 104 is formed in the upper wall 32 in side-by-side relationship immediately adjacent each of the lifting lugs 100. The sizing and positioning of the recesses 104 and lifting lugs 100 is complementary, whereby two tanks 10A can be stacked in top-to-top relationship as shown in Fig. 14, with the lifting lugs 100 of one of the tanks 10A received in the recesses of the other of the tanks 10A. This aids in positioning the tanks 10A for transport or storage and reduces incidents of damage to the lifting lugs 100 during transport.

The dome shaped ends 28 and 30 of the tank 10A are slightly modified to provide a castellated extension 106 on the flat end-facing wall 63. The provision of this castellated extension at each end facilitates the mounting of vents or inlet piping to the tank 10A by raising the height where an opening can be placed, thus allowing more liquid to be received into the tank 10A because the vent and inlet can be positioned at a greater height and remain above the level of the liquid in the tank 10A.

The receiving pockets 38 in tank 10A are modified such that the upright inboard walls 44A are oriented to be substantially parallel with an upright axis through the longitudinal axis of the tank, which is located at the same position as line 4-4 of Fig. 2. Further, the base walls 46A are provided with openings 108 therein. The openings 108 in each of the base walls 46A are fluidically connected by upright tubular members 110 integrally formed with the shell 12 by kiss-offs in the rotational molds. The tubular members 110 are best seen in Figs. 12 and 13, and are integrally molded with the shell to prevent the escape of liquid from the tank 10A or the intrusion of liquid or debris into the tank. The tubular members 110 may be configured as tapered, frustoconically shaped tubes 112 as shown in Fig. 12, which taper from a greater cross-sectional area of the opening 108A in the upper receiving pocket 38A of the superposed pair to the opening 108B in the lower receiving pocket 38A' of the pair. Alternatively, the tubular members may be configured with an hourglass shape having a waist 112 with a narrower cross-sectional area than either of the openings in the upper receiving pocket or the

lower receiving pocket of the superposed pair as illustrated in Fig. 13. The tubular members provide structural support within the tank 10A and increase rigidity, and further a flow of some of the water or other liquid which collects on the base walls 46A to drain through the tubular members 110 rather than around the outside of the walls.

Figs. 15 and 16 show a third embodiment of the tank 10B. Tank 10B is similar in all respects to tank 10A, with the exception that no reinforcements are provided between the base walls 46B of the receiving pockets 38B. The base walls 46B are substantially smooth and are imperforate. In many applications, the reinforcement pockets 38B will provide sufficient structural rigidity that no internal reinforcements are needed. Also, the limited amount of ribbing on the tanks 10, 10A and 10B allows relatively greater wall thickness without the addition of resin during the molding process. A typical wall thickness of a 1000 gallon tank having a thin wall where substantially ribbing is required is about 1/4 inch, whereas substantially the same amount of resin produces a wall thickness of ½ inch in a tank having little or no ribbing, such as the tanks hereof. Thus, the tanks of the present invention which have little or not ribbing utilize the receiving pockets 38 to gain structural rigidity without the necessity of adding substantial additional resin to increase wall thickness.

Figs. 17 and 18 show a modified version of the tank 10C of Figs. 15 and 16, wherein the receiving pockets 38C have a greater vertical extension than the receiving pockets of tanks 10, 10A and 10B. The receiving pockets 38C are imperforate and do not include openings in their base walls 46C. The side walls 40C and 42C as well as the upright inboard wall 44C have a greater vertical extension, such that the depth of the pockets 38C is increased in a direction transverse to the longitudinal axis of the tank 10C. The base walls 46C of the receiving pockets 38C which are in substantial vertical alignment meet at a junction 114 formed by a kiss-off in the rotational molding process, such that the resin forming the shell fuses together at the junction 114. The base walls 46C form an inlet 116 outboard of the junction 114 as seen in Fig. 18, but the inlet 116 does not fluidically communicate with the chamber 16. The base walls 46C also form a cove 118 inboard of the junction 114 which fluidically communicates with the chamber 16. The inlets 116 and the coves 118 lie outboard of the vertical plane passing through the longitudinal axis of the tank 10C, which is in the same location as illustrated by line 4-4 of Fig. 2. The junction 114 extends longitudinally along the receiving pocket 38C to connect to the side walls 40C and 42C and is positioned more proximate the upright inboard wall 44C than the closest side wall 39 and thus allows the upright inboard walls 44C and the side walls 40C and 42C of the lower receiving pocket 38C of the pair of receiving pockets to provide support to the upper receiving pocket 38C positioned thereabove.

In use, after a hole or pit is excavated in the ground for receiving the tank 10 and suitable preparation such as a liner or gravel or sand is poured into the excavated pit to provide a base, the shell 12 is lowered into the pit. A sling may be used to lower the shell 12, or alternatively cables with hooks or the like may be connected to the lifting lugs or to the stabilization lugs at the corners of the shell for lifting and lowering the shell 12 into position. Added support and stability may be achieved by contouring the pit to conform to the receiving pockets 38 in the upper wall 32 and/or lower wall 39. That is, the receiving pockets 38 provide locations for anchoring the tank by resisting movement, and further gain structural support not only in the shell 12 as designed, but also by providing a location for the receipt of external support by providing earth fill or adding masonry support into the receiving pockets 38. Rods or stakes may be driven through the holes 66 and into the ground in the pit for holding the shell in position, and pipes may be connected to suitable fittings to deliver and discharge liquid and/or liquids and solids into the shell 12 and vents installed as shown in the dashed lines in Figs. 1, 9 and 15. As noted above, risers may be coupled to the manways 20 depending on the depth of the upper side of the shell relative to the surface of the soil surrounding the tank 10 as ultimately graded. Covers 14 are then mounted on the manways 20 or risers, and then the final grading is performed and the tank 10 is ready for use.

The receiving pockets 38 are uniquely configured such that their upright inboard walls 44 are at least about 15% and preferably about 20% or more of the height of the shell 12, and the base walls 46 are at least about 15% and preferably about 20% or more of the width of the shell 12. The 90° angle between the upright inboard wall 44 and the base wall 46 acts like a gusset to aid in transferring the loads from a horizontal to a vertical direction and vice versa. By providing arcuate wall surfaces adjacent and intermediate the receiving pockets, the receiving pockets 38 not only give support to resist flattening or "parallelogramming" of the tank 10 when external loads are placed on the tank, but also serve to transfer loads in a vertical direction to a horizontal direction so that the side fill in the pit around the shell 12 yields additional support. Vertical loads might be caused by a tractor or other vehicle driving over the tank. Horizontal loads might be caused by ground heave, seismic events or traffic on the surface not over but adjacent to the tank. Thus, the receiving pockets 38 may transfer side loading through the base wall 46 to the upright inboard wall 44 to more evenly distribute external forces to the earth supporting the tank.

Another advantage of the present invention is that even though external forces or weight of the contents of the tank may cause minor deformations, such deformations are largely isolated from the manway and the cover secured thereon. By the provision of the trough surrounding the collar, the trough permits yielding of the

adjacent wall while limiting the transfer of deformation to the collar. This is beneficial in allowing access to be gained to the interior of tank notwithstanding a large passage of time during which many external events may have occurred which would bind the cover in other synthetic resin subterranean tanks.

Although preferred forms of the invention have been described above, it is to be recognized that such disclosure is by way of illustration only, and should not be utilized in a limiting sense in interpreting the scope of the present invention. Obvious modifications to the exemplary embodiments, as hereinabove set forth, could be readily made by those skilled in the art without departing from the spirit of the present invention. For example, as noted above, the shell 12 may be provided with relatively thinner walls by providing circumferentially extending transverse ribs in the outer wall. Multiple passages with fittings may be provided for additional pipes to deliver or discharge liquid. PVC T-pipes may be provided internally of the tank, and the pipes may extend downwardly to the bottom of the tank for connection to a pump for pumping water or other liquid from the tank.

The inventor hereby states his intent to rely on the Doctrine of Equivalents to determine and assess the reasonably fair scope of his invention as pertains to any apparatus not materially departing from but outside the literal scope of the invention as set out in the following claims.